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# PERFORMANCE MEASUREMENTS ON THE AN/TRM7(XA-1) SERIAL NUMBER 1, FIELD-STRENGTH METER

by

A. H. Dove

U. S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Boulder Laboratories
Boulder, Colorado

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Technical Note No. 2



Prepared
for
Rome Air Development Center
Air Research and Development Command
United States Air Force
Griffiss Air Force Base
New York

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## FOREWORD

This is an interim report which covers the examination and evaluation of the AN/TRM-7(XA-1) field-strength meter. This work was sponsored by Rome Air Development Center, Air Force Systems Command, United States Air Force, Griffiss Air Force Base, New York. The management and technical supervision of this program was under the cognizance of Mr. L. F. Moses of RADC.

The author wishes to express his appreciation to George Blake for his assistance in making measurements and to C. C. Watterson and H. V. Cottony for suggestions contributed.

# PERFORMANCE MEASUREMENTS ON THE AN/TRM7(XA-1), SERIAL NUMBER 1, FIELD-STRENGTH METER


## Abstract

The Radio Field Intensity Meter AN/TRM7(XA-1) has been technically evaluated and compared with the T-A/NF105. The frequency range of the tests was 140 kc to 25 Mc/s.

Performance measurements were conducted with the AN/TRM7(XA-1) to determine the accuracy of the indicator circuitry and its ability to furnish realistic data on radiated radio frequency fields. These tests show the accuracy to be ± 5% for CW and sine wave signals within a closed circuit. The AN/TRM7(XA-1) contains two calibration sources, namely the impulse generator and the continuously tunable sine wave generator. These methods of calibration are adequate for average use. Operational limits are determined by the frequency and repetition rate of the signal to be measured. This can be a source of error perhaps. It is suggested that calibration charts be utilized to evaluate such sources of errors.

Variation in receiver gain with changes in line voltage, long and short term, was found to be less than 1%. Antenna transfer characteristics were found to be within 0.3db at 5Mc/s and within 0.5db from 5 to 24 Mc/s.

Comparison of the AN/TRM7(XA-1) and the T-A/NF105 indicated that differences in the measurement of field strength were generally less than 1%.

The AN/TRM7(XA-1) performance measurements met all of the requirements specified in MIL-I-6181D.

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PERFORMANCE MEASUREMENTS ON THE AN/TRM7(XA-1) SERIAL NUMBER 1, FIELD-STRENGTH METER

## 1. INTRODUCTION

This report describes the performance measurements of the AN/TRM7(XA-1) Serial No. 1.

The AN/TRM7(XA-1) is a highly sensitive superhetrodyne receiver covering the frequency range of 150 kc to 25 Mc/s. Measurement of rf interference, noise, and field intensity of signals is made possible by precalibration. The AN/TRM7(XA-1) is basically a selective two-terminal voltmeter, with a signal sensitivity of 1 microvolt to 10 volts. Three types of measurements are available by means of a selector control: slideback peak, quasi-peak, and field strength.

The frequency selector circuits are the conventional superheterodyne radio receiver type and need little explanation as to theory and operation. However the choice of time constants and impulse bandwidth of the receiver affect the accuracy of the detector and the indicator circuitry.

The average pulse width of the impulse response is the inverse of the IF impulse bandwidth. If, for example, the impulse bandwidth of the IF is 10 kc the average maximum pulse width is 100 microseconds. This means that the direct reading peak VTVM charge time for a field intensity meter having a 10 kc impulse bandwidth has to be less than 100 microseconds. It follows then that the VTVM will, within the limits of its low-frequency response, respond to the peak of the noise generated in the receiver front end. The capabilities of the slideback peak VTVM will mostly be determined by the audio amplifier. The audio amplifier, which serves the function of slideback detector cutoff-point indicator, must have enough gain and output stage drive to produce an audible output level when measuring low-duty-cycle pulsed interference. The minimum pulse width which will appear at the input to the audio amplifier is, as previously indicated, equal to the reciprocal of the receiver's impulse bandwidth.

This report covers only one part of the large field strength measurement program and is intended only as a report on the laboratory measurements of the AN/TRM7(XA-1) as a tuned voltmeter. The calibration (including the antenna) was performed by the calibration center at NBS Boulder Laboratories.

Reference is made here to similar tests performed by the University of Pennsylvania, Moore School of Electrical Engineering and described in their report entitled "Investigation of the Measurement of Noise".

## 2. DESCRIPTION OF EQUIPMENT

The AN/TRM7(XA-1) is a superheterodyne receiver which can be used to measure rf voltages in six bands of the radio spectrum from 150 kc to 25.0 Mc/s at sensitivities ranging from 10 microvolts to 10 volts. The major components consist of a radio interference field intensity meter (or monitor), a quasi-peak value indicator, power supply, antenna tripod, antenna with coupler, and an antenna coupler to be used with a radio frequency line probe and the necessary cable assemblies for making the connections between units. See Figures 1 and 2.

### 2.1 Description of Major Components

The monitor unit is the control and metering unit of the Interference Meter. The front panel serves as a mounting for the meters, operating controls, indicating devices, audio and video output jacks, cable receptacles and handles. The monitor unit contains the following sub-assemblies:

a. IF amplifier
b. RF amplifier
c. CW calibrator
d. Impulse calibrator
e. Indicator
f. RF attenuator
g. Two IF attenuators
h. Audio amplifier

These assemblies can be removed for servicing.

The power supply is a separate unit and provides electronically regulated dc voltages of +150, -150, -450, and +6.3 volts to the equipment. An ac voltage of 6.3 volts is also provided. This power supply is designed to operate from a 115 or 230 volt, 60 cycle source. Regulation for line voltage variation from 100 to 130 volts and 200 to 260 volts is provided. The source voltage is selected by means of a front panel panel line-voltage switch.

The quasi-peak value indicator is used in conjunction with the monitor unit when a quasi-peak measurement is required. A four-foot interconnecting cable connects the indicator to the monitor unit.

The antenna is a three-section, telescoping rod which extends to 41inches. This antenna covers the entire frequency range of the monitor and may be used vertically or horizontally as a linear pick-up device.

The antenna coupler is provided as an antenna matching network for the omnidirectional antenna and line probe. The antenna band switch positions correspond to the six bands on the monitor.

The rf line probe is used to investigate the conduction of rf interference in power lines. This probe consists of a series capacitor which provides protection against the shock hazard of high voltages (up to 1000 volts) and is connected to the antenna coupler when in use.

## 3. PERFORMANCE TESTS

It became apparent during the work on this project that some basic test method would be useful to determine the relative performance of different field strength meters. Therefore a set of acceptance tests have been developed for this purpose. An effort has been made to describe tests which effect realistic field strength measurements and to supplement the conclusions of this report with calibration charts and curves.

The results of these measurements are:

### 3.1 Noise Figure

Internal noise is defined as the signal produced at the output of the equipment with no signal being fed at the input and with the gain adjusted to normal.

Because the AN/TRM7(XA-1) is a heterodyne type of receiver, it is expected to have, in general, more than one output for each input frequency. In such cases there are spot noise figures for image response. (See test NO3-9 of this report.)

### 3.2 Frequency Scale Tracking Error

As originally received, the monitor or field intensity meter was checked for frequency calibration. Comparisons were made at several points distributed throughout the frequency range and the differences were recorded. The first trial indicated that rf and I.F. alignment was required; the errors were as much as 20%. After alignment the field intensity meter was checked again for frequency calibration by tuning a signal of a calibrated signal generator for a response at a given receiver frequency and was measured using a transfer oscillator and frequency counter at the frequencies tested. The calibration error did not exceed 0.2%. The frequency calibration is presented in Figure 3 as percentage error.

### 3.3 Attenuator Calibration

This calibration was performed with the function selector in the "field intens" position, the antenna-50 ohm selector in the "50 ohm" position, and the receiver gain standardized in accordance with the instruction manual. The corrected attenuator settings are referenced to the "40" db attenuator as correct. This calibration is believed to be accurate within 0.1db + 0.3% of the attenuation in db. Refer to test report 50351 prepared by Division 92.

| Attenuator Setting decibels | Corrected Attenuator Setting decibels | |
|---|---|---|
| | 0.15 Mc | 24.0 Mc |
| 0 | -0.3 | 0.5 |
| 20 | 19.7 | 20.5 |
| 40 | 40.0 | 40.0 |
| 60 | 60.1 | 60.1 |
| 80 | 80.1 | 80.1 |
| 100 | 100.1 | 100.1 |

The insertion loss of the external 20 db attenuator pad, No. CN-584 AN/TRM7(XA-1) was measured when terminated in the 50 ohm input of the AN/TRM7(XA-1) receiver.

| Frequency Mc | Insertion Loss decibels |
|---|---|
| 0.15 | 19.9 |
| 10.0 | 19.9 |
| 24.0 | 19.9 |

It was observed that the attenuator pad in the 40 db steps was quite frequency sensitive; therefore this pad was calibrated at several additional frequencies to ascertain its characteristics. This change appears to be caused by impedance changes in the rf section of the receiver. The data listed below are the measured attenuation values in the "40" db step, and not the corrected attenuator settings.

| Band | Frequency Mc/s | Measured Attenuation from the "20" to "40" db steps decibels |
|---|---|---|
| 1 | 0.15 | 20.3 |
| | 0.20 | 19.9 |
| | 0.25 | 19.6 |
| | 0.30 | 19.8 |
| | 0.35 | 20.0 |
| 2 | 0.35 | 19.8 |
| | 0.55 | 19.8 |
| | 0.83 | 20.2 |
| 3 | 0.83 | 21.3 |
| | 1.00 | 20.9 |
| | 1.40 | 20.8 |
| | 1.95 | 20.8 |

### 3.4 Two Terminal rf Voltmeter Calibration

This calibration was performed by applying 100 microvolts to the signal input receptacle with the signal attenuator in the "20" db position, the function selector in the "field intens" position, the antenna-50 ohm selector in the "50" ohm position, and the receiver gain standardized in accordance with the instruction manual. In some cases it was necessary to place the signal attenuator in the "40" db position when reading the panel meter in order to have an on-scale reading. The impulse calibrator settings are equivalent to an input of 100 microvolts. The input voltage was accurate within 3 percent.

Refer to test report 50351 prepared by Division 92.

| Band | Frequency Mc | Signal Attenuator Position db | Meter Reading db | Impulse Calibrator Settings db |
|---|---|---|---|---|
| 1 | 0.15 | 20 | 20.2 | 79.2 |
| | 0.20 | 20 | 19.6 | 78.5 |
| | 0.25 | 20 | 19.4 | 78.4 |
| | 0.30 | 20 | 19.6 | 78.2 |
| | 0.35 | 20 | 19.7 | 78.8 |
| 2 | 0.35 | 20 | 19.4 | 78.6 |
| | 0.45 | 20 | 19.5 | 78.8 |
| | 0.55 | 20 | 19.4 | 78.7 |
| | 0.65 | 20 | 19.6 | 79.0 |
| | 0.75 | 20 | 19.8 | 79.4 |
| | 0.83 | 20 | 20.0 | 79.2 |
| 3 | 0.90 | 40 | -0.4 | 82.6 |
| | 1.00 | 40 | -0.2 | 82.4 |
| | 1.20 | 40 | -0.1 | 82.3 |
| | 1.40 | 40 | 0.0 | 82.4 |
| | 1.60 | 40 | -0.1 | 82.3 |
| | 1.95 | 40 | -0.1 | 82.4 |
| 4 | 1.95 | 40 | 0.4 | 82.1 |
| | 2.50 | 20 | 20.0 | 79.4 |
| | 3.00 | 40 | 0.0 | 82.6 |
| | 3.50 | 40 | -0.2 | 83.0 |
| | 4.00 | 40 | -0.5 | 82.8 |
| | 4.60 | 40 | -0.6 | 83.0 |
| 5 | 4.6 | 40 | -0.2 | 82.6 |
| | 5.8 | 20 | 20.0 | 79.2 |
| | 7.0 | 20 | 20.2 | 79.2 |
| | 8.2 | 20 | 20.3 | 79.6 |
| | 9.5 | 20 | 20.2 | 80.0 |
| | 10.8 | 20 | 20.2 | 80.0 |
| 6 | 10.8 | 20 | 18.5 | 78.9 |
| | 13.0 | 20 | 18.6 | 79.0 |
| | 16.0 | 20 | 18.4 | 78.8 |
| | 19.0 | 20 | 18.6 | 79.4 |
| | 22.0 | 20 | 19.2 | 79.7 |
| | 23.5 | 20 | 19.8 | 80.6 |
| | 24.0 | 20 | 19.0 | 80.0 |

### 3.5 Meter Scale Tracking Calibration

The meter scale tracking test evaluates the ability of the instrument to correctly indicate amplitudes below full scale. It was assumed that the AN/TRM7(XA-1) was calibrated at full scale.

In this case, meter scale tracking was determined by comparing the calibrated output attenuator of the signal generator with the indicated voltage of the AN/TRM7(XA-1).

The accuracy of the indicator circuitry was tested at the center frequency of each band. The results of this test are shown below. It will be noted that the greatest error is 3%.

| rf (Mc/s) | Sig. Gen. (μv) | TRM-7 Meter (μv) | rf (Mc/s) | Sig. Gen (μv) | TRM-7 Meter (μv) |
|---|---|---|---|---|---|
| 0.25 | 100 | 100 | 3.2 | 100 | 100 |
| Band I | 90 | 90 | Band IV | 90 | 89 |
| | 80 | 80 | | 80 | 79 |
| | 70 | 71 | | 70 | 70 |
| | 60 | 59 | | 60 | 59 |
| | 50 | 48 | | 50 | 49 |
| | 40 | 39.5 | | 40 | 40 |
| | 30 | 29.3 | | 30. | 29.5 |
| | 20 | 20.5 | | 20 | 20.6 |
| 0.60 | 100 | 100 | 7.5 | 100 | 100 |
| Band II | 90 | 89 | Band V | 90 | 90 |
| | 80 | 79 | | 80 | 80 |
| | 70 | 70 | | 70 | 72 |
| | 60 | 58.5 | | 60 | 61 |
| | 50 | 48.5 | | 50 | 50 |
| | 40 | 39.8 | | 40 | 41 |
| | 30 | 29.5 | | 30 | 30.5 |
| | 20 | 20.5 | | 20 | 21 |
| 1.5 | 100 | 100 | 18 | 100 | 100 |
| Band III | 90 | 90 | Band VI | 90 | 89 |
| | 90 | 81 | | 80 | 80 |
| | 70 | 72 | | 70 | 70 |
| | 60 | 60 | | 60 | 59 |
| | 50 | 50 | | 50 | 49.5 |
| | 40 | 40 | | 40 | 40 |
| | 30 | 29.8 | | 30 | 30 |
| | 20 | 20.5 | | 20 | 20.7 |

### 3.6 Gain Stability with Changes in Power Line Voltage

With a 1000 microvolt indication on the output meter, power line voltages were varied from 105 to 125 volts (from a variac) to test the operation of the voltage regulator. No appreciable variation in the readings was observed.

| Line Voltage | Output Meter Indication $\mu v$ |
|---|---|
| 105 | 995 |
| 107 | 995 |
| 109 | 997 |
| 111 | 998 |
| 113 | 999 |
| 115 | 1000 |
| 117 | 1000 |
| 118 | 1000 |
| 119 | 1000 |
| 121 | 1000 |
| 123 | 1000 |
| 125 | 1000 |

### 3.7 Bandwidth Measurements

Bandwidth is commonly defined as the range over which the response does not fall below the response at the center frequency by more than some specified value. In this case, 6 db was chosen. Tests were made at 250 kc and 10 Mc/s, where IF frequencies of 455 kc and 1600 kc respectively are used in the AN/TRM7(XA-1) receiver.

With the AN/TRM7(XA-1) tuned to 250 kc the gain control was set for full scale deflection with a 1000 microvolt input. With the function switch in the peak position and the gain standardized, the signal generator was set at a succession of frequencies. The resulting output was then plotted in db versus frequency and the resulting curves are illustrated in Figures 4 and 5 .

## 3.8 Image and IF Rejection

The ratios here determined give the relative gain of the receiver to an input signal at its tuned frequency and an input signal image of the IF frequency in db.

The AN/TRM7(XA-1) was tuned to a driving signal generator frequency with the gain control adjusted for full scale deflection. Then, without changing the receiver frequency or changing the gain control, a signal was introduced equal to the tuned frequency, plus or minus the IF frequency. These readings were observed and recorded. The results obtained are illustrated in Figure 6.

## 3.9 Local Oscillator Radiation

The local oscillator radiation was determined by measuring the strength of the local oscillator signal which appeared at the input jack of the equipment under test.

The TA/NF 105 field-strength meter was used to determine the amplitude of this radiation. In most cases the amplitude was too small to detect; however, the results obtained at image frequencies are given below.

| IF Freq. (Mc) | RF Freq. (Mc) | Band | Oscil. Freq. (Mc) | L.O. Radiation (μv) |
|---|---|---|---|---|
| 0.455 | 0.15 | I | 0.605 | 1.8 |
| | 0.30 | I | 0.755 | 1.6 |
| | 0.36 | I | 0.815 | 1.6 |
| | 0.80 | III | 1.255 | 6.0 |
| | 1.00 | III | 1.455 | 5.2 |
| | 2.00 | III | 2.455 | 3.0 |
| 1.600 | 0.40 | II | 2.00 | 9.0 |
| | 0.60 | II | 2.20 | 7.6 |
| | 0.80 | II | 2.40 | 7.1 |
| | 2.80 | IV | 4.40 | 24.0 |
| | 3.80 | IV | 5.40 | 1.0 |
| | 4.80 | IV | 6.40 | 4.6 |
| | 6.00 | V | 7.60 | 7.2 |
| | 8.00 | V | 9.60 | 9.6 |
| | 10.00 | V | 11.60 | 7.4 |
| | 12.00 | VI | 13.60 | 45.0 |
| | 18.00 | VI | 19.60 | 44.0 |
| | 26.00 | VI | 27.60 | 32.0 |

### 3.10 Shielding Effectiveness

The AN/TRM-7(XA-1) was set up to receive signals from the broadband antenna AT887. This loop type antenna is capable of receiving signals over the entire frequency range of the receiver. After tuning the AN/TRM7(XA-1) field-intensity meter to the signal generator frequency, the amplitude was adjusted for full scale deflection with 0.1 millivolt antenna input. The receiver was then disconnected from the antenna and capped. The loss in intensity was observed and found to be greater than 50 db. With the AN/TRM-7(XA-1) in its most sensitive position, the antenna of the signal generator was placed within two feet of the receiver and oriented directly toward the receiver case to determine leakage of the receiver. No indication was observed over the entire frequency range of the receiver which is well within the requirements of Mil-I-6186D.

### 3.11 Antenna Calibration

Loop antenna AT-887(XA-1) was calibrated in accordance with the standard-field method. This is accomplished by placing the antenna in a known field and recording magnitude of the field measured by the AN/TRM-7(XA-1); the antenna coefficient is then determined by the ratio of the known field to the field measured by the AN/TRM-7(XA-1). The known field is generated by a single turn, unshielded, balanced transmitting loop, and the magnitude of the field is computed from the dimensions of the transmitting and receiving antenna, the spacing between the bops and the transmitting loop current [Jean, Taggart, and Wait 1961]. The known field is calculated in terms of the quasi-static magnetic field, H, and the magnitude of the equivalent electric component, E, that would exist in a free-space radiation field as determined by the relationship $E = ZH$, where Z is the impedance of free space. Refer to test report 50351 prepared by Division 92.

The calibration was performed with the function selector in the "Field Intens" position, the antenna-50 ohm selector in the "Ant" position and the receiver gain standardized in accordance with the instruction manual. The loop antenna was connected to the receiver by the 20-foot cable, CG-409 E (XA-1)/U. This calibration is believed accurate within 0.3 db to 5 Mc/s and within 0.5 db from 5 to 24 Mc/s.

| Band | Frequency Mc/s | Antenna Coefficient decibels |
|---|---|---|
| 1 | 0.15 | 30.5 |
| | 0.20 | 28.5 |
| | 0.25 | 30.2 |
| | 0.30 | 31.4 |
| | 0.35 | 32.5 |
| 2 | 0.35 | 27.9 |
| | 0.45 | 28.2 |
| | 0.55 | 29.2 |
| | 0.65 | 29.8 |
| | 0.75 | 28.6 |
| | 0.83 | 26.8 |
| 3 | 0.83 | 28.6 |
| | 0.90 | 26.0 |
| | 1.00 | 23.4 |
| | 1.20 | 23.2 |
| | 1.40 | 25.0 |
| | 1.60 | 26.2 |
| | 1.95 | 27.4 |
| 4 | 1.95 | 18.4 |
| | 2.50 | 16.7 |
| | 3.00 | 17.4 |
| | 3.50 | 18.4 |
| | 4.00 | 19.2 |
| | 4.60 | 19.6 |
| 5 | 4.6 | 14.6 |
| | 5.8 | 10.0 |
| | 7.8 | 10.3 |
| | 8.2 | 12.0 |
| | 9.5 | 12.8 |
| | 10.8 | 14.3 |
| 6 | 10.8 | 15.7 |
| | 13.0 | 15.4 |
| | 16.0 | 13.6 |
| | 19.0 | 14.3 |
| | 22.0 | 13.5 |
| | 23.5 | 13.5 |
| | 24.0 | 13.4 |

## 3.12 Input Impedance

The input impedance of the receiver was measured by connecting the signal input receptacle to the bridge by means of the 20 foot cable, CG-409 E(XA-1)U, with the gain of the receiver standardized in accordance with the instruction manual, the function selector in the "Field Intens" position, and the antenna-50 ohm selector in the "50" ohm position.

| Frequency Mc | Input microvolts | Attenuator Position decibels | Impedance ohms |
|---|---|---|---|
| 1.0 | 10 | 0 | 6.0±j0 |
| | 1,000 | 20 | 41.0±j0 |
| | 1,000 | 40 | 51.6±j0 |
| | 10,000 | 60 | 51.5±j0 |
| | 30,000 | 80 | 51.4±j0 |
| | 30,000 | 100 | 51.5±j0 |

## 3.13 Pulse Response

The quasi-peak detector develops an output amplitude which depends upon the pulse width and the pulse repetition frequency. The width of the pulses applied to the detector is determined by the preselector circuits and their pass band characteristics. Pulse width less than the reciprocal of the bandwidth (10 kc or 100 microseconds) was used. In this case, 1 microsecond pulses were introduced at the input of the AN/TRM-7(XA-1) and amplitude measurements and comparison of quasi-peak readings to peak readings were made while the repetition rate was varied.

Pulse response with changes in repetition rate is illustrated in Figures 7, 8, 9, 10, 11, and 12. Pulse response with changes in pulse width is illustrated in Figures 13 and 14. Differences are attributed to impulse bandwidth of the receiver.

## 3.14 Pulse Linearity

The purpose of this test was to determine the amplitude of non-linearity for applied pulses. The pulse width here was 1 microsecond (as in the previous test) and several repetition frequencies were employed.

The rf gain was set so that an input pulse of 100 microvolts peak gave a quasi-peak indication as compared to peak readings for the same pulse. The input signal was then increased to 500 microvolts and the gain reduced to produce the same level signal as before. In effect the latter situation is an artificial one deliberately arranged so that a test of overall linearity could be made. The linearity, with five times the previous signal level through the rf stages, is illustrated in Figure 15.

### 3.15 Sine Wave Generator
### (Amplitude and constancy over the frequency range)

The purpose of this test was to determine the maximum power available from the calibration sine wave generator.

With the indicator standardized to full scale or 10 microvolts, with the attenuators in the 0 db position, and with the function switch in the CW position and the attenuator in the 20 db position, and with the power set trimmer adjusted to maximum deflection, indications were that the power set was resonate and synchronous with the selector circuits. The power set control was then advanced to read full scale (or to the calibrate position). A total of 100 microvolts was needed for calibration. The results of this test are shown in graph form in Figure 16.

### 3.16 Overall Linearity Calibration

The overall linearity was measured from the signal input receptacle to the panel output meter, referred to a meter reading of 20 decibels. The measurements were performed with the function selector in the "Field Intens" position, the antenna-50 ohm selector in the "50 ohm" position, and the receiver gain standardized in accordance with the instruction manual. The overall linearity was measured with the signal attenuator in both the "20" and "80" db positions; these attenuator positions are indicated in the calibration data. This calibration is believed accurate within 0.1 db + 0.3% of the attenuation in db. Refer to test report 50351 prepared by Division 92.

| Meter Reading decibels | Corrected Meter Readings decibels | | | | | |
|---|---|---|---|---|---|---|
| | Band 1, 0.25 Mc | | Band 2, 0.55 Mc | | Band 3, 1.4 Mc | |
| | 20 db | 80 db | 20 db | 80 db | 20 db | 80 db |
| 0 | -0.5 | -0.4 | -0.4 | -0.4 | -0.5 | -0.4 |
| 5 | 5.0 | 5.0 | 5.1 | 5.0 | 5.0 | 5.0 |
| 10 | 10.2 | 10.2 | 10.3 | 10.2 | 10.2 | 10.2 |
| 15 | 15.2 | 15.2 | 15.2 | 15.2 | 15.2 | 15.2 |
| 20 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| | Band 4, 3.5 Mc | | Band 5, 7.0 Mc | | Band 6, 19.0 Mc | |
| | 20 db | 80 db | 20 db | 80 db | 20 db | 80 db |
| 0 | -0.4 | -0.4 | -0.3 | -0.4 | -0.3 | -0.3 |
| 5 | 5.1 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| 10 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 |
| 15 | 15.2 | 15.2 | 15.2 | 15.2 | 15.2 | 15.2 |
| 20 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |

### 3.17 Gain Stability

The test of gain stability for long periods was performed by standardizing the receiver gain to read 100 microvolts full scale. With the gain of the TRM7 fixed, the signal generator was reduced to 60 microvolts. After a warm-up period of one hour readings were tabulated. The highest and lowest readings are indicative of the variability to be expected over long periods.

| Band | RF Freq. (Mc) | Meter 1st half hr. | Meter 2nd half hr. | Meter 3rd half hr. | Meter 4th half hr. | Max. Change (μv) |
|---|---|---|---|---|---|---|
| I | 0.25 | 60μv | 52μv | 43.5μv | 42μv | -18 |
| II | 0.60 | 60μv | 57.5μv | 53μv | 47μv | -13 |
| III | 1.30 | 60μv | 58μv | 57μv | 57μv | -3 |
| IV | 3.30 | 60μv | 58μv | 57μv | 57μv | -3 |
| V | 8.00 | 60μv | 59μv | 58μv | 58μv | -2 |
| VI | 18.00 | 60μv | 64μv | 64μv | 62μv | +4 |

3.18 Correlation

The AN/TRM-7(XA-1) and the NF-105 were used to compare measurements of CW signals thru a coaxial switch. The receivers were given a 30-minute warmup time and with equal ambient temperature. A calibrated CW signal of 100 microvolts was fed into the coaxial switch. The output of the coaxial switch then fed to the receivers alternately and readings were taken at the same indicated frequency. Three readings were taken on each frequency band and recorded. The results of this test are shown below.

| rf (Mc) | Sig. Gen Input (μv) | NF-105 (μv) | TRM-7 (μv) |
|---|---|---|---|
| 0.15 | 100 | 96 | 98 |
| 0.23 | 100 | 100 | 93* |
| 0.36 | 100 | 97 | 100 |
| 0.46 | 100 | 85* | 100 |
| 0.66 | 100 | 85* | 100 |
| 0.87 | 100 | 92 | 100 |
| 1.12 | 100 | 102 | 101 |
| 1.65 | 100 | 102 | 101 |
| 2.10 | 100 | 98 | 100 |
| 2.70 | 100 | 99 | 100 |
| 4.00 | 100 | 100 | 100 |
| 5.20 | 100 | 101 | 100 |
| 6.7 | 100 | 88* | 100 |
| 9.7 | 100 | 100 | 99 |
| 12.7 | 100 | 104 | 108* |
| 16.2 | 100 | 98 | 130* |
| 23.2 | 100 | 97 | 119* |
| 26.7 | 100 | 95 | -- |

## 4. REMARKS ON RECEIVED CONDITION

The AN/TRM-7(XA-1) and associated units sent to NBS for testing had apparently been damaged in shipment. The equipment was repaired in the laboratory and then subjected to a retest. The results given in this report indicate the characteristics of the equipment after repair.

The erratic operation of the band selector unit seems to downgrade the equipment from the standpoint of field service. This difficulty was caused by improper contact of the metal fingers of the tuning head. As the contacts deteriorate the detent does not line up for proper contact of the metal fingers. This requires the removal of the dust cover and shielding plates to gain access for making adjustments as required.

It was determined that a complete realignment was necessary before tests of any kind could be made. The rf section was found to be out of alignment along with the mixer stage. In some cases the trimmer capacitors were broken and rf slotted inducters were broken; in most cases it was necessary to replace them.

The power supply gave very little trouble and could be adjusted to meet the requirement. Time delay relay K802 became a source of failure due to high resistance contacts 6 and 7. The schematics furnished by the company show that the initial current passes thru contacts 6 and 7. The current rating of the contacts is less than the total load required. It is suggested that a relay with higher contact current rating be used. Relay K802 was replaced with one the same type for these tests to avoid modification and rewiring of the circuits.

The equipment met all the requirements specified in MIL-I-6181D after being repaired and recalibrated.

## 5. DISCUSSION

In the presence of high ambient interference or high hiss level of the equipment, an accurate carrier measurement may be performed in the following manner: a. Note the meter reading in microvolts produced by the combined noise and carrier levels, b. Detune the equipment sufficiently to lose the carrier signal. c. Note the reading produced by the noise level alone. The following formula applies:

$$S = \sqrt{A^2 - N^2}$$

in which S is the unknown carrier level, A the combined noise and carrier level and N the noise level (all in microvolts). For example, if the combined noise and signal level is 50 microvolts and the noise level 30 microvolts, the true signal level would be:

$$S = \sqrt{50^2 - 30^2}$$

or 40 microvolts.

Tuned selective circuits of the AN/TRM-7(XA-1) are provided with IF cathode traps in the rf section to keep the rejection above 60 db. In channel 6 however, there are no traps. This provides higher rf gain, therefore IF rejection will suffer because of the broad-banding and low gain of the rf section for this channel.

When making measurements with the AN/TRM-7(XA-1) it may be well to keep in mind what the readings represent. For CW or sine wave signals, the VTVM responds to the peak value in the field intensity position and peak position. The meter face is calibrated in rms values of the sine wave. For pulse and pulse modulated signals, the VTVM responds to the peak of the carrier in the field intensity position and to the peak of the sine wave form in peak position. The meter is calibrated in terms of rms values.

## 6. CONCLUSION

After repair, the equipment performance met all the requirements specified in MIL-I-6181D.

Accurate field-strength measurements are possible when calibration charts such as the ones provided within this report are used.

## 7. REFERENCES

Friis, H. T., Noise figures of radio receivers, Proc. IRE, 419 (July 1944).

Jean, A. G., H. E. Taggart, and J. R. Wait, Calibration of loop antennas at VLF, J. Res. Vol. 65, 3 (July-Sept 1961).

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Robert W. Landee, Donovan C. Davis and Albert P. Albrecht, Electronic Measurements, 2nd Edition, McGraw-Hill Book Co., Inc., New York(1952).

Mischa Schwartz, Information Transmission, Modulation, and Noise, McGraw-Hill Book Co., Inc., New York (1959).

Frederick Emmons Terman, Sc. D., and Joseph Mayo Pettit, Ph. D., Electronic Measurements, 2nd Edition, McGraw-Hill Book Co., Inc., New York (1952).

| NO | NOMENCLATURE | TYPE NO |
|---|---|---|
| 1 | POWER SUPPLY | PP-2177(XA-1) TRM-7 |
| 2 | CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL | CX-4584(XA-1)/U (4 FEET 0 INCHES) |
| 3 | INDICATOR, QUASI-PEAK VALUE | ID-747(XA-1) TRM-7 |
| 4 | RADIO INTERFERENCE FIELD INTENSITY METER | IM-150(XA-1) TRM-7 |
| 5 | TRIPOD, ANTENNA | AB-622(XA-1) TRM-7 |
| 6 | ANTENNA | AT-887(XA-1) TRM-7 |
| 7 | CABLE ASSEMBLY, POWER ELECTRICAL | CX-4582(XA-1)/U (6 FEET 0 INCHES) |
| 8 | CABLE ASSEMBLY, POWER ELECTRICAL | CX-4581(XA-1)/U (7 FEET 0 INCHES) |

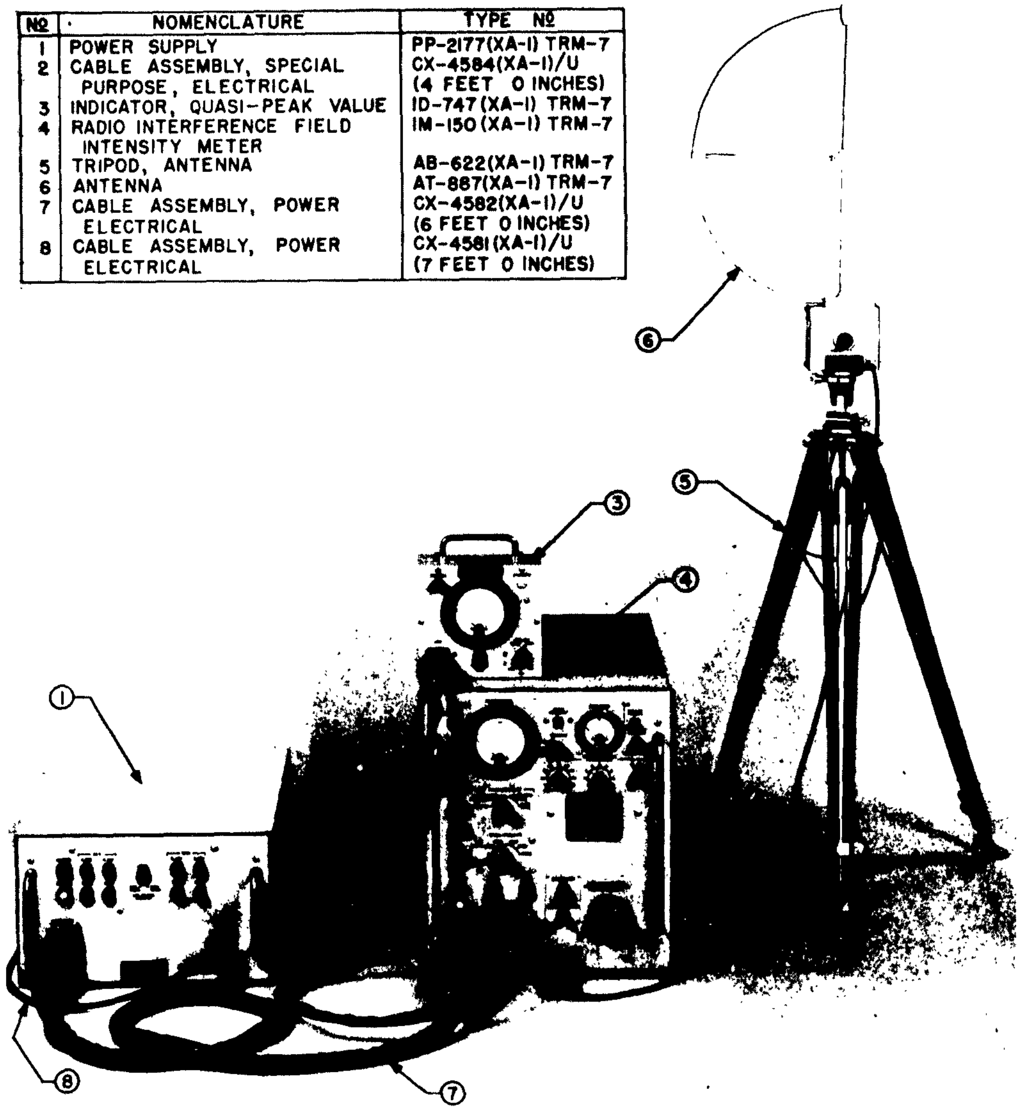


Fig. 1 RADIO INTERFERENCE MEASURING SET AN/TRM-7 (XA-1)

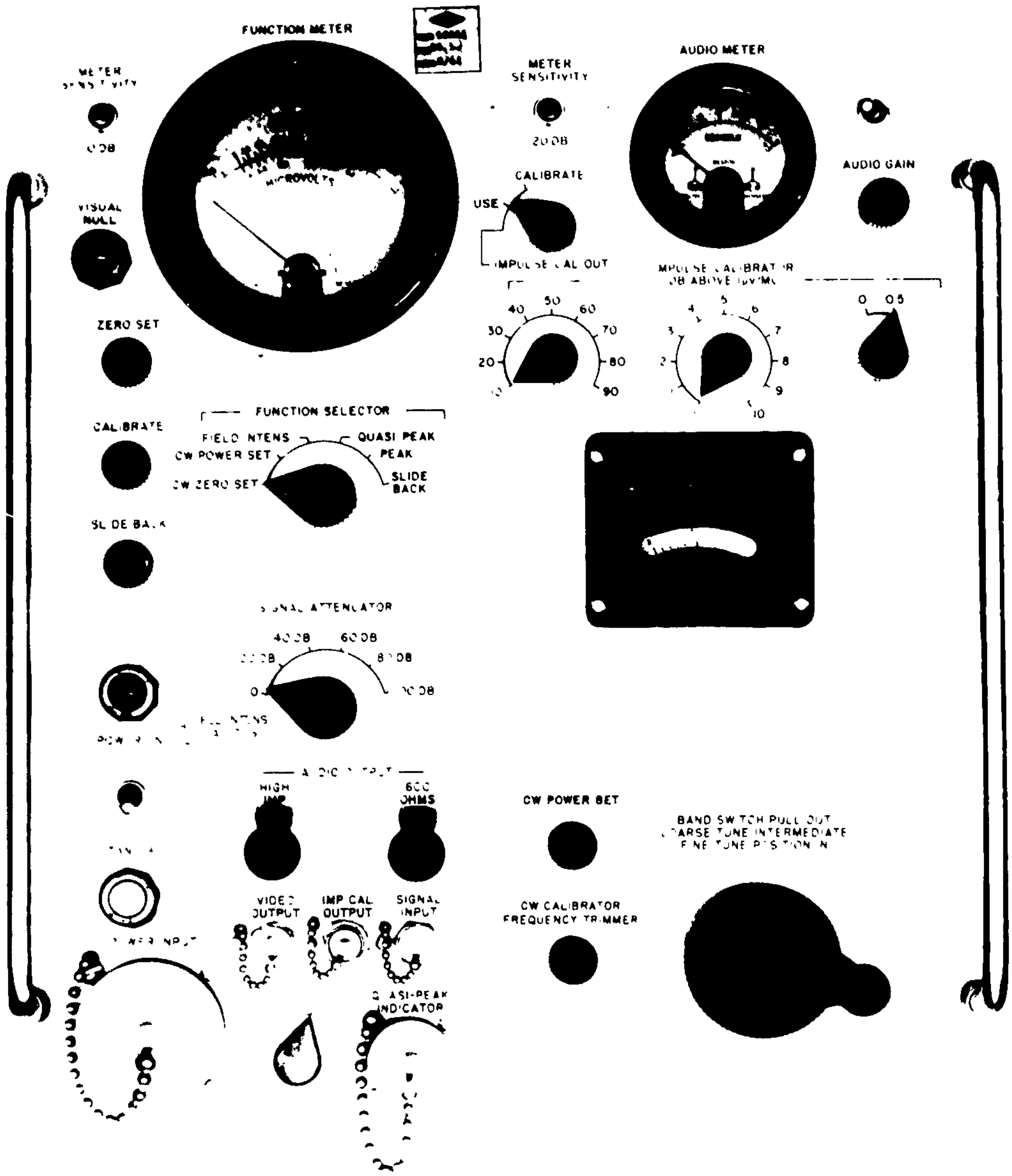


Fig. 2 INTERFERENCE METER CONTROLS

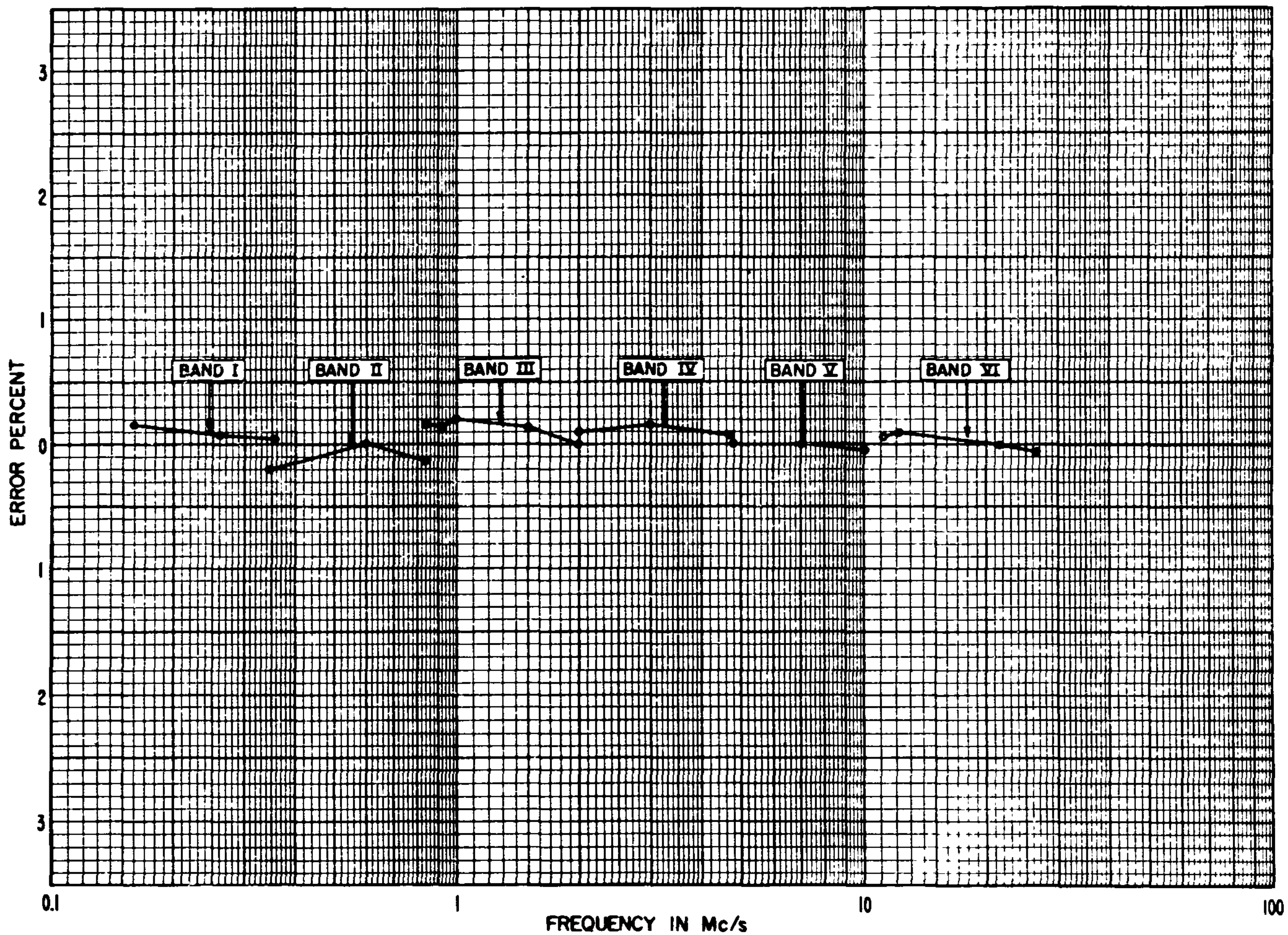


Fig. 3 FREQUENCY TRACKING ERROR

B- 32669

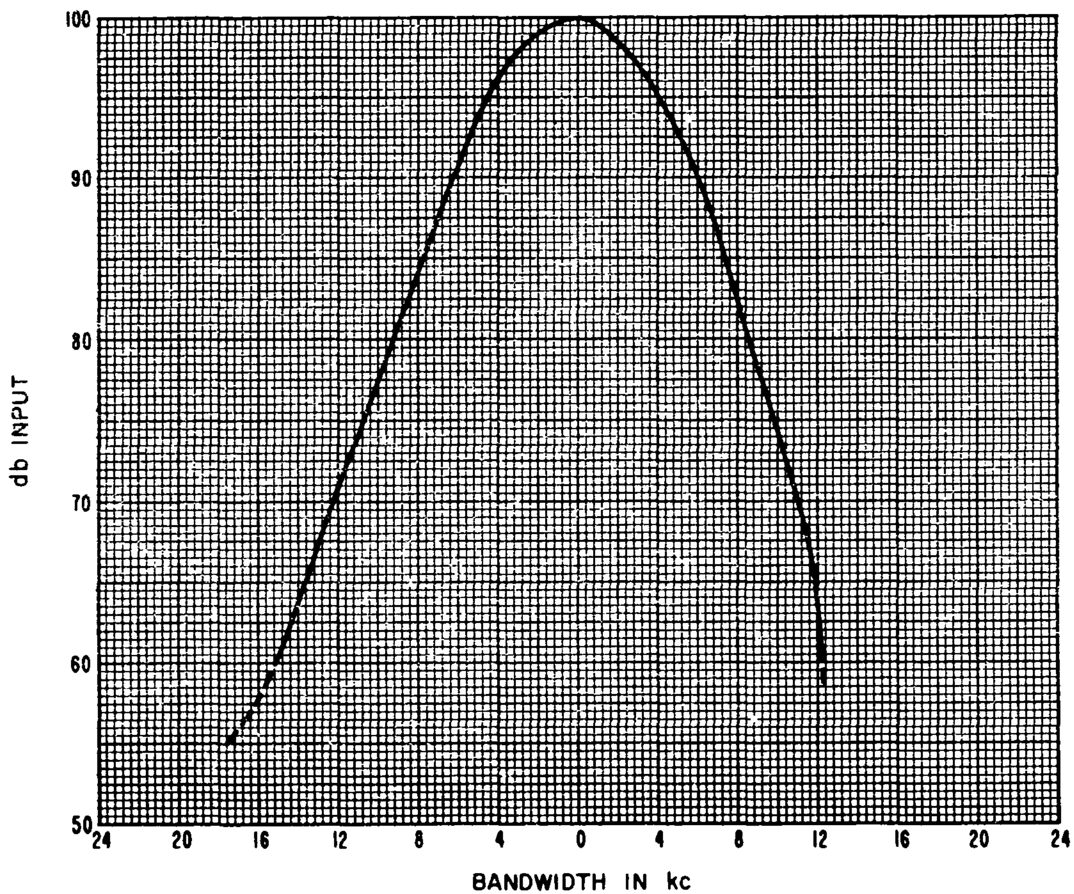


Fig. 4 PLOT OF FREQUENCY RESPONSE VS. CHANGE IN db INPUT AT CENTER FREQUENCY OF 0.25 Mc/s

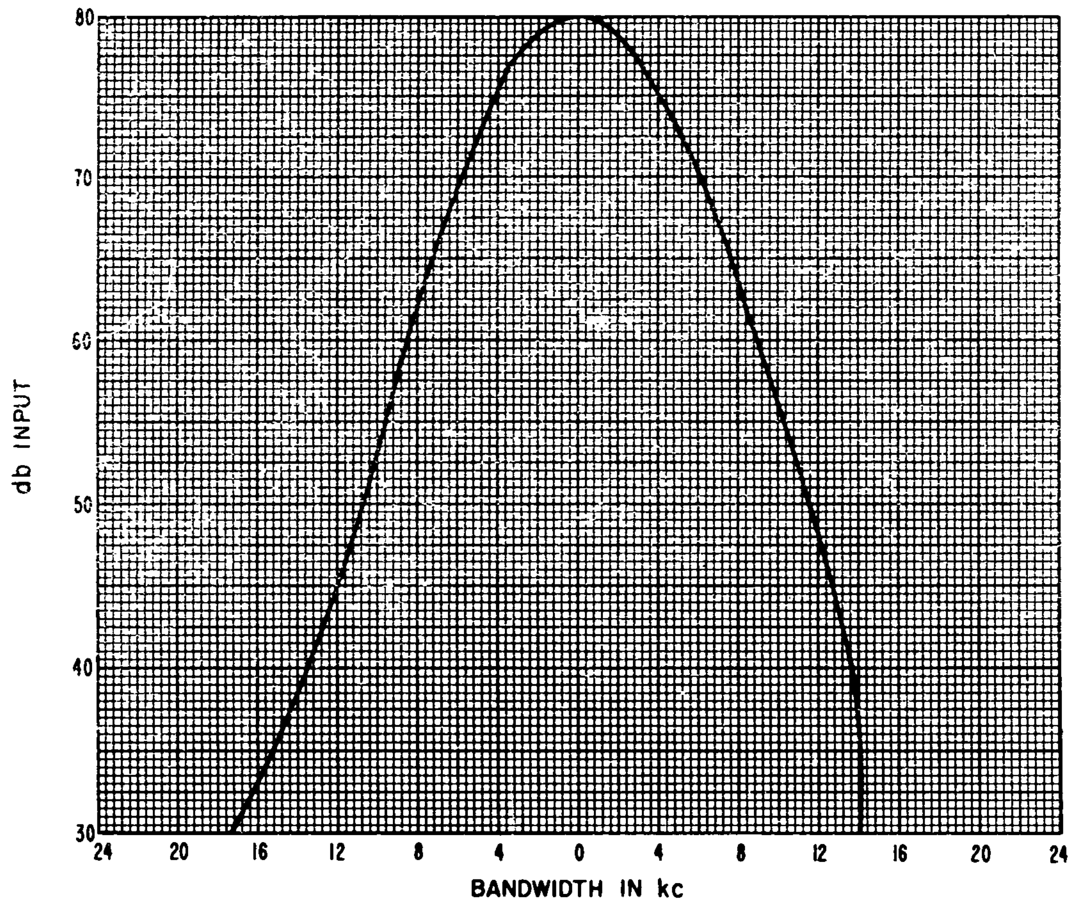


Fig. 5 PLOT OF FREQUENCY RESPONSE VS. CHANGE IN db INPUT AT CENTER FREQUENCY OF 10 Mc/s

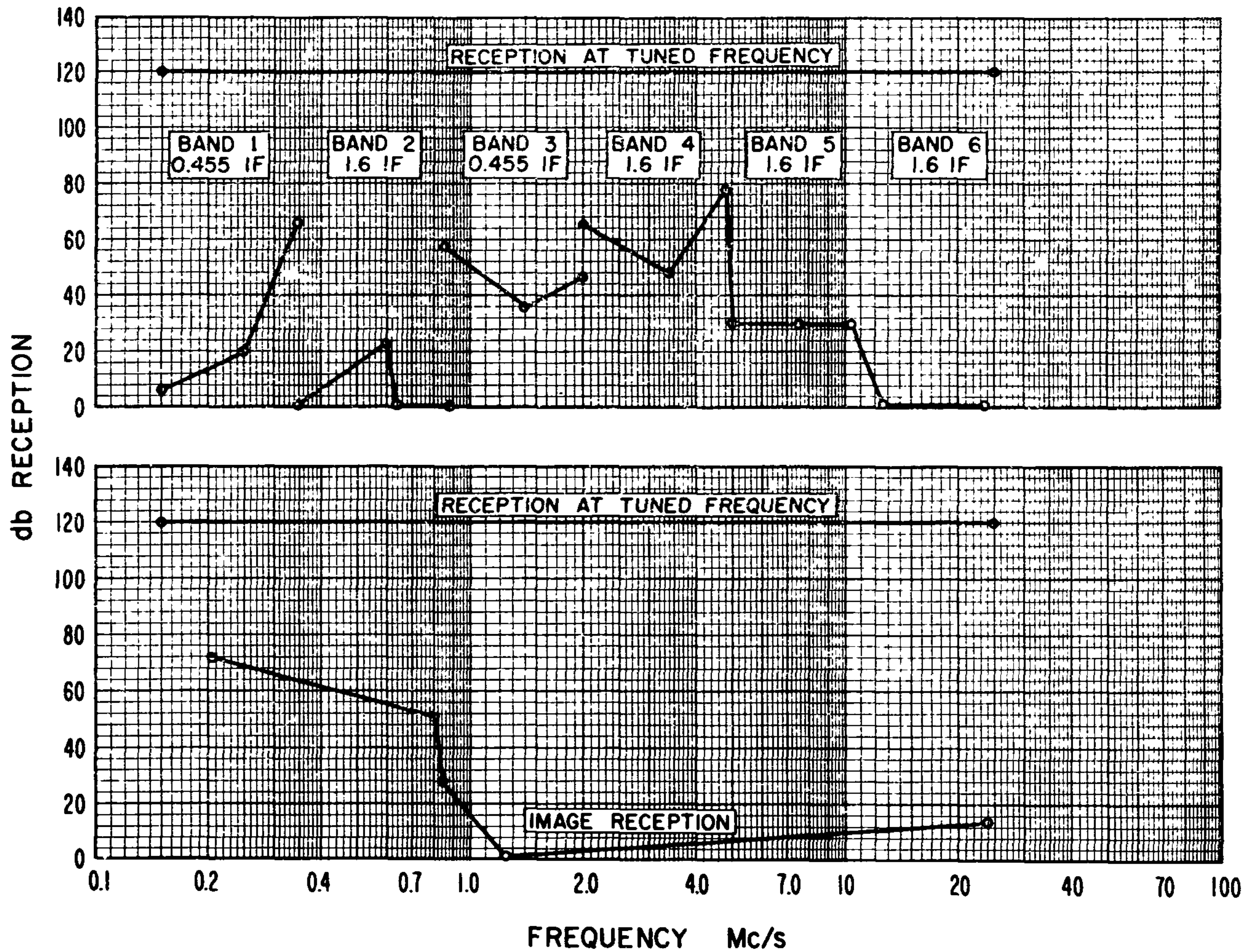


Fig. 6 IMAGE AND IF REJECTION

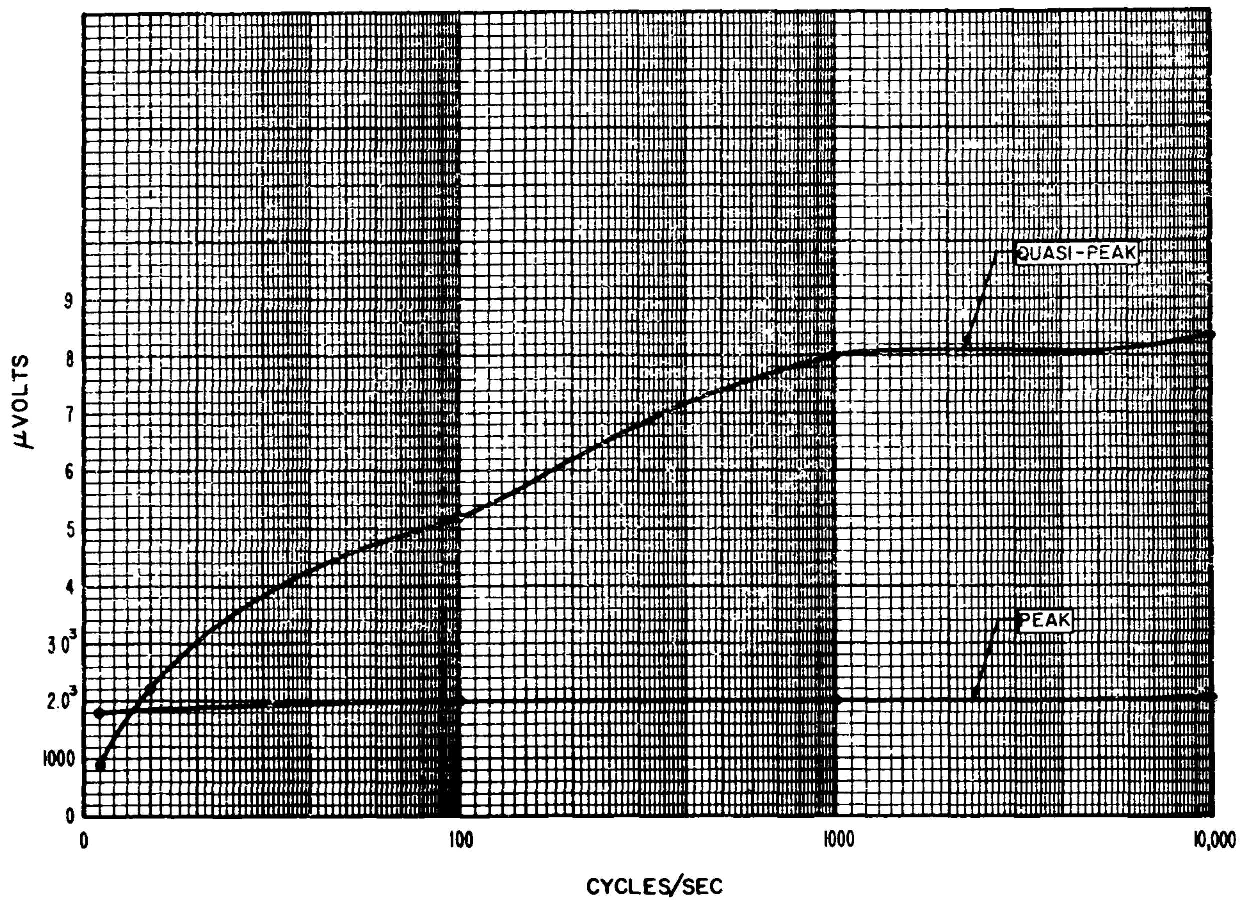


Fig. 7 1 μSEC. PULSE RESPONSE WITH CHANGES IN REPETITION RATE, 0.15 Mc/s

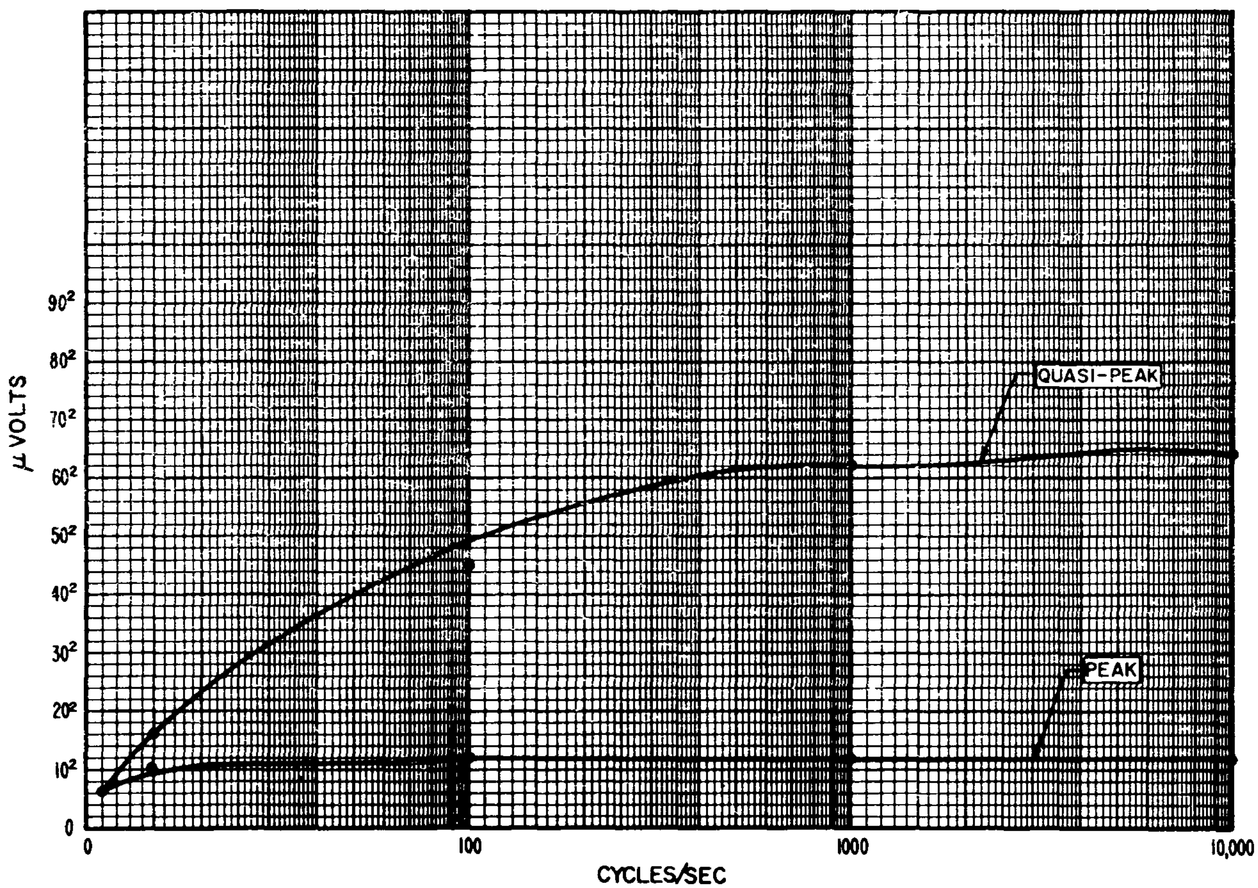


Fig. 8 I $\mu$SEC. PULSE RESPONSE WITH CHANGES IN REPETITION RATE, 0.25Mc/s

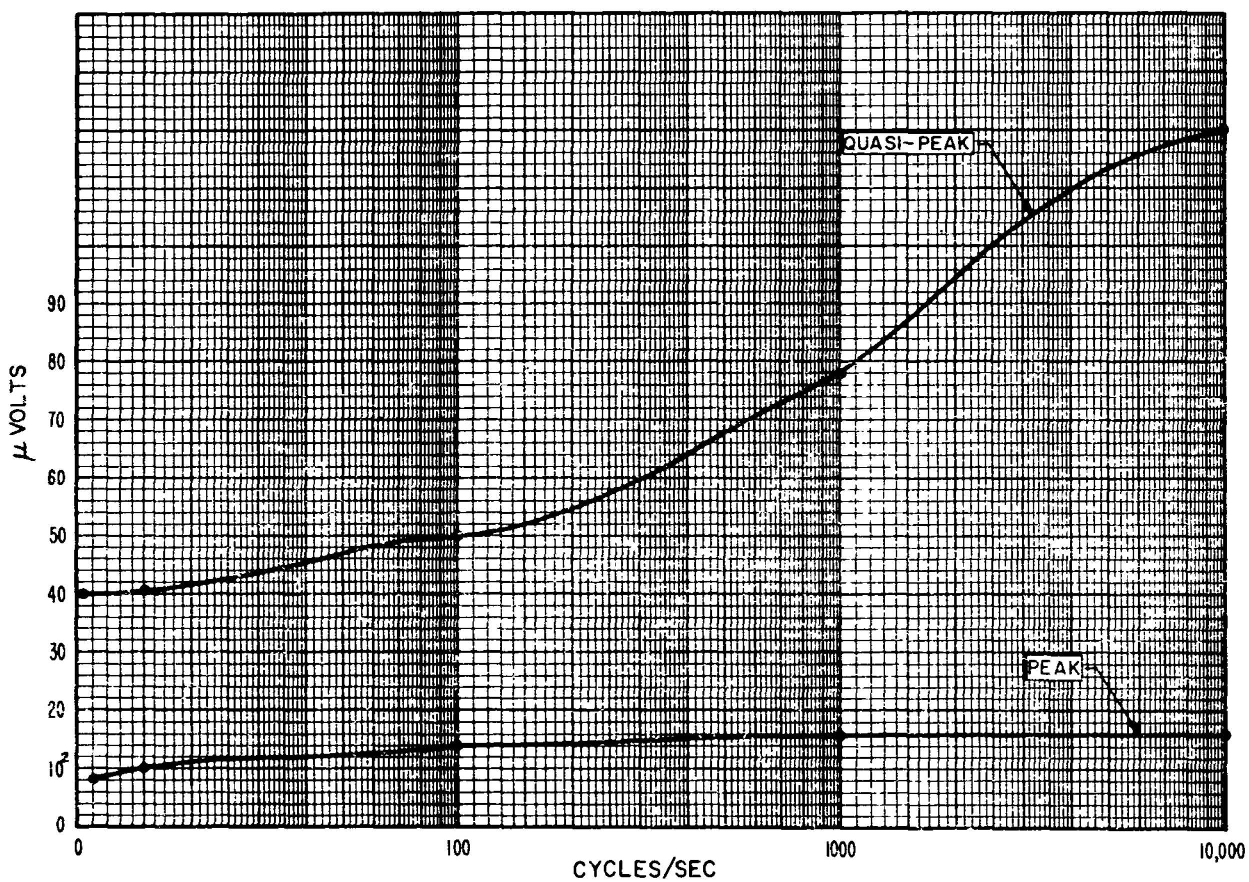


Fig. 9  1 μSEC. PULSE RESPONSE WITH CHANGES IN REPETITION RATE, 1.0 Mc/s

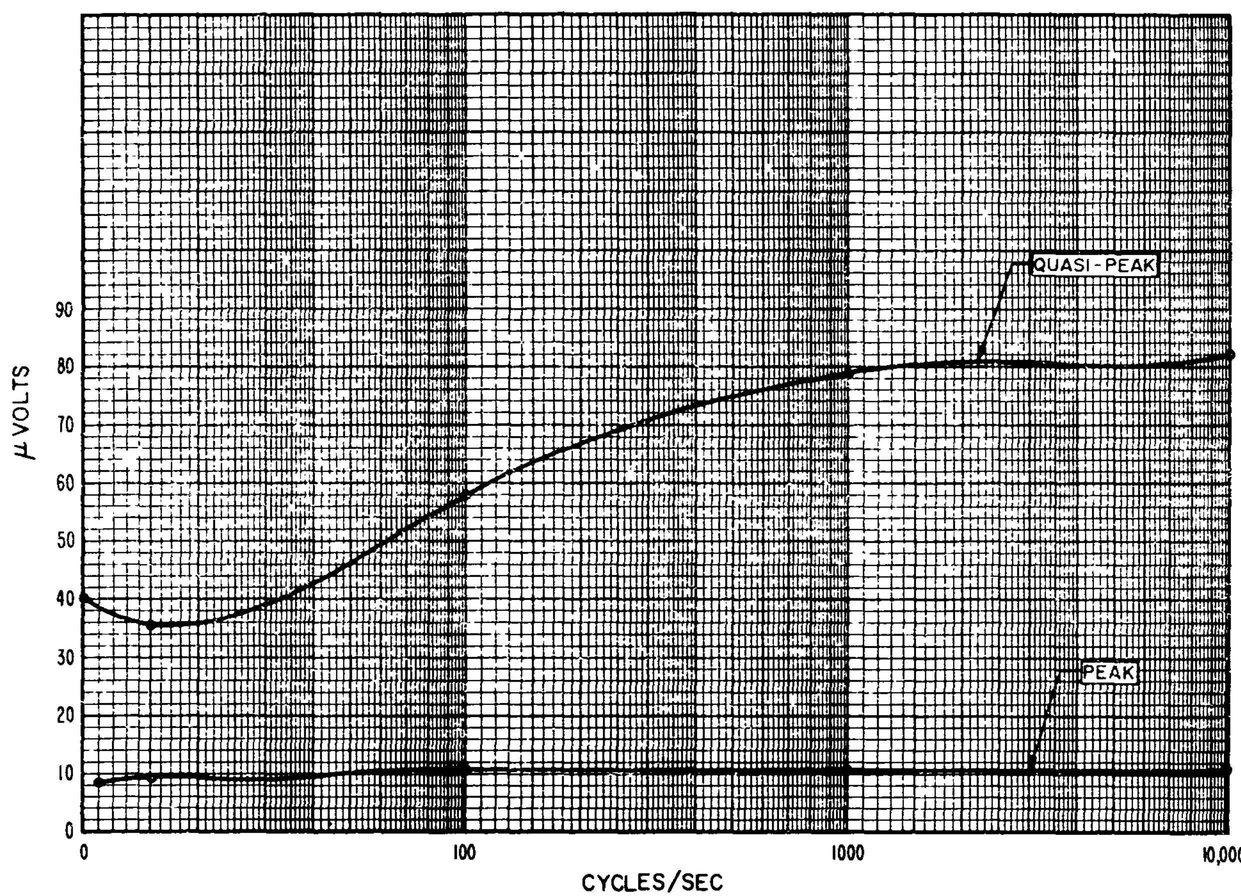


Fig. 10 I μSEC. PULSE RESPONSE WITH CHANGES IN REPETITION RATE, 6 Mc/s

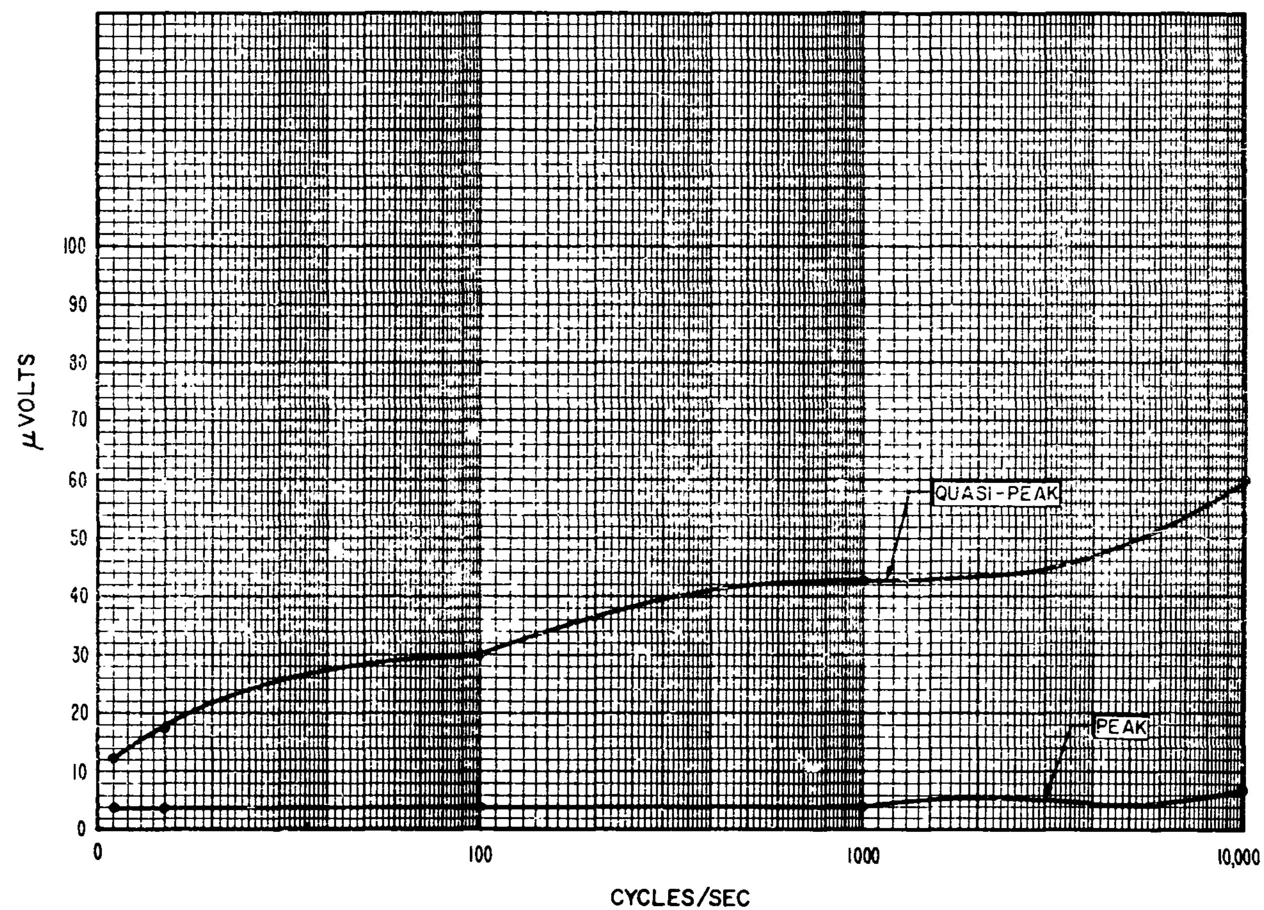


Fig. 11 I μSEC. PULSE RESPONSE WITH CHANGES IN REPETITION RATE, 10 Mc/s

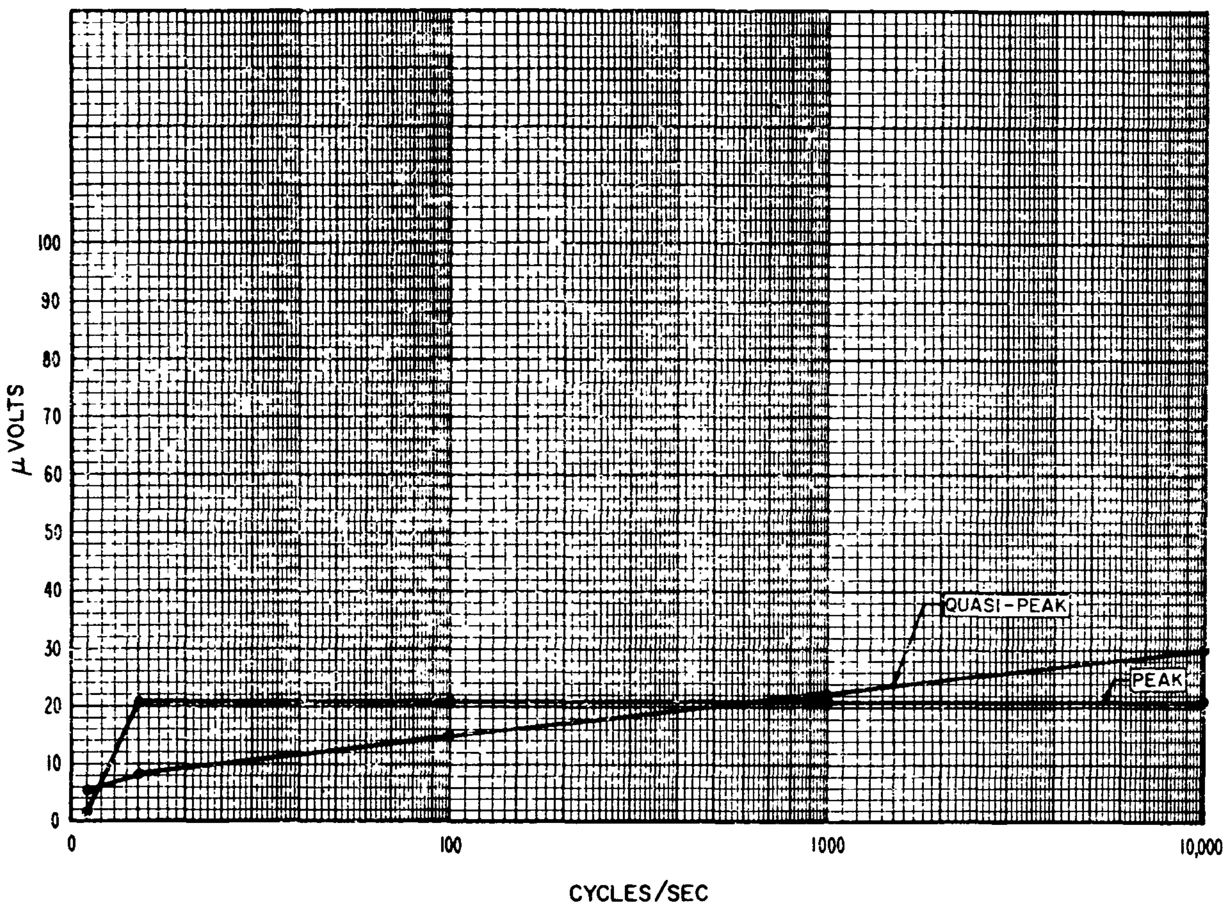


Fig. 12 1 μSEC. PULSE RESPONSE WITH CHANGES IN REPETITION RATE, 20 Mc/s

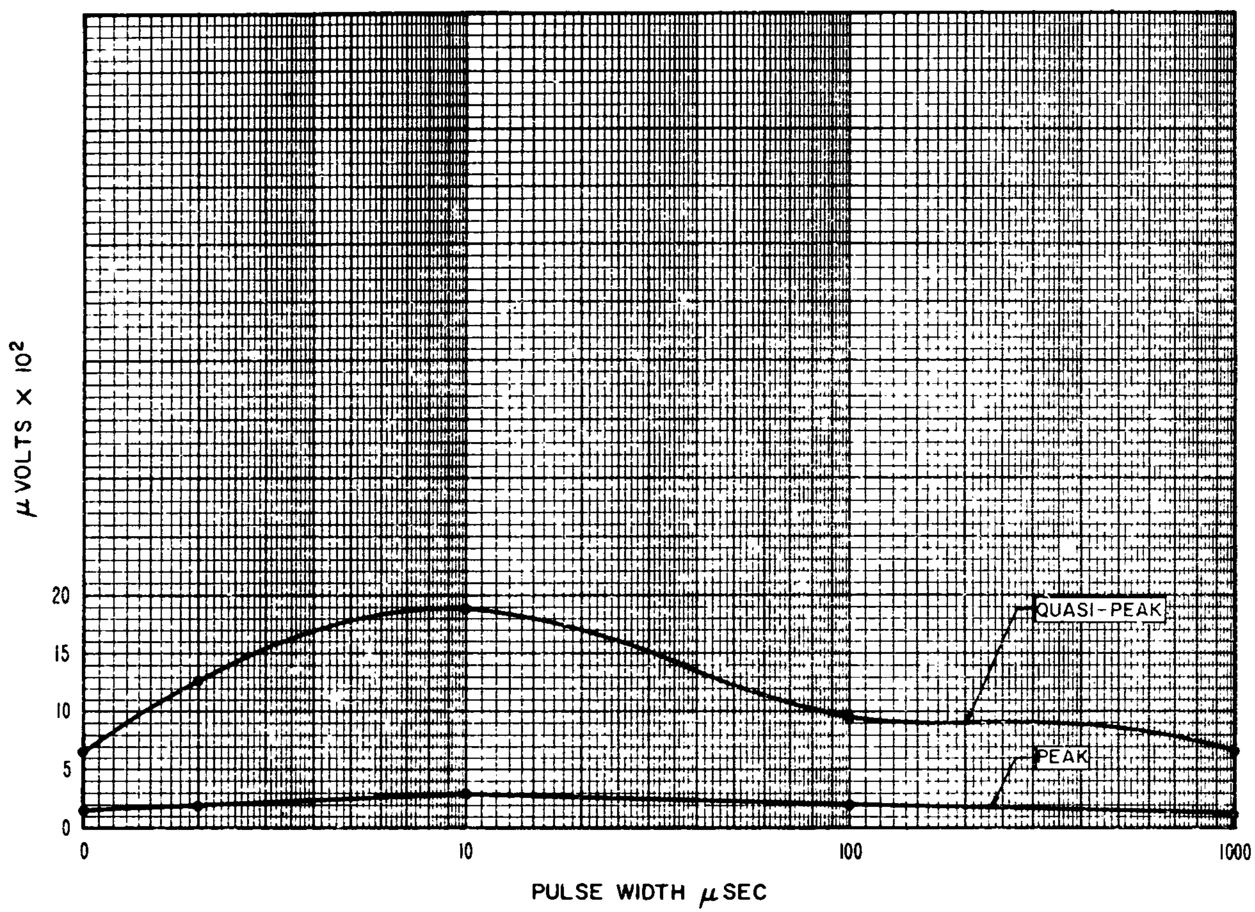


Fig. 13 PULSE RESPONSE WITH CHANGES IN PULSE WIDTH BAND III 1.0 Mc/s

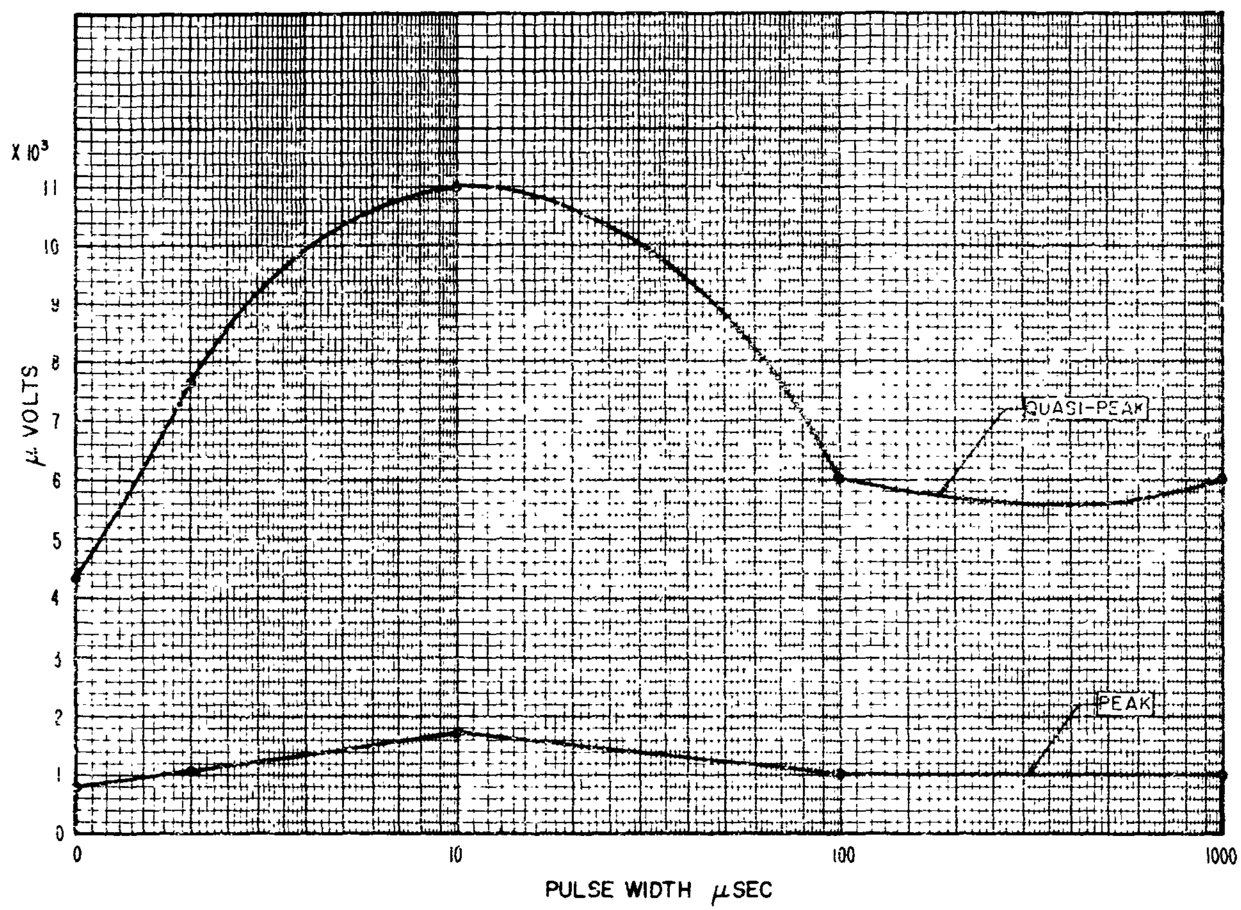


Fig. 14 PULSE RESPONSE WITH CHANGES IN PULSE WIDTH
BAND I 0.15 Mc/s

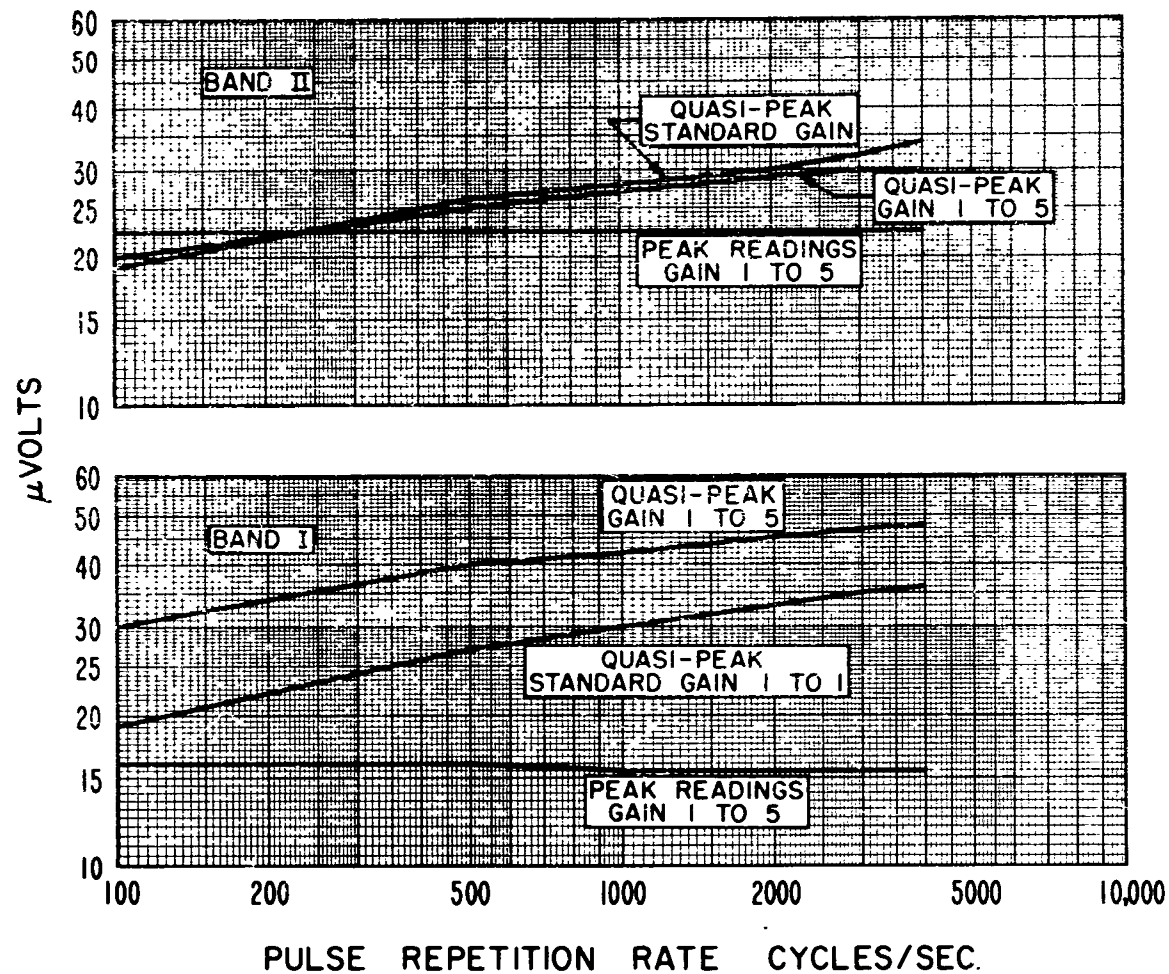


Fig. 15 **PULSE LINEARITY**

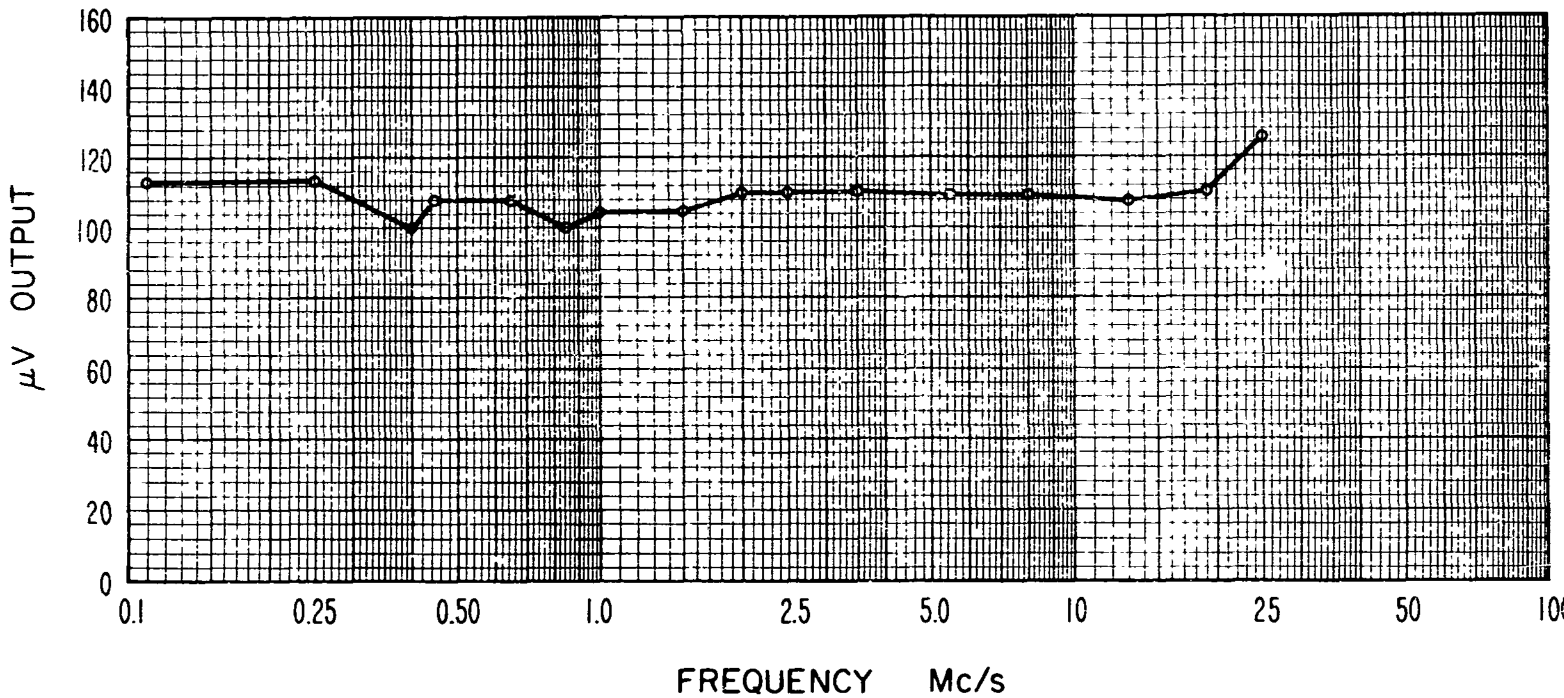


Fig. 16 **SINEWAVE GENERATOR AMPLITUDE AND CONSTANCY**